V. ADDRESSING SEA-LEVEL RISE IN COASTAL DEVELOPMENT PERMITS

New development in the coastal zone generally requires a coastal development permit (CDP).[20] In areas without a certified LCP, the Commission is generally responsible for reviewing the consistency of CDP applications with the policies of Chapter 3 of the Coastal Act (Public Resources Code sections 30200-30265.5). In areas with a certified LCP, the local government is responsible for reviewing the compliance of CDP applications with the requirements of the certified LCP and, where applicable, the public access and recreation policies of the Coastal Act. Certain local government actions on CDP applications are appealable to the Commission. On appeal, the Commission also applies the policies of the certified LCP and applicable public access and recreation policies of the Coastal Act. The Commission and local governments may require changes to the project or other mitigation measures in order to assure compliance with Coastal Act policies or LCP requirements and both minimize risks to the development from coastal hazards and avoid impacts to coastal resources.

Many of the projects reviewed through the CDP application process already examine sea-level rise as part of the hazards analysis. Such examination will need to continue, and these guidelines offer direction and support for thorough examination of sea-level rise and its associated impacts based on current climate science, coastal responses to changing sea level and consequences of future changes.

All locations currently subject to inundation, flooding, wave impacts, erosion or saltwater intrusion will be exposed to increased risks from these coastal hazards with rising sea level. Locations close to or hydraulically connected to these at-risk locations, will themselves be at-risk as sea level rises and increases the inland extent of these hazards. To comply with Coastal Act Section 30253 or the equivalent LCP section, projects will need to be planned, located, designed and engineered for the changing water levels and associated impacts that might occur over the life of the development. In addition, project planning should anticipate the migration and natural adaptation of coastal resources (beaches, access, wetlands, etc.) due to these future sea-level rise conditions in order to avoid future impacts to those resources from the new development.

[20] Coastal Act Section 30106 defines "Development" to be, “on land, in or under water, the placement or erection of any solid material or structure; discharge or disposal of any dredged material or of any gaseous, liquid, solid, or thermal waste; grading, removing, dredging, mining, or extraction of any materials; change in the density or intensity of use of land, including, but not limited to, subdivision pursuant to the Subdivision Map Act (commencing with Section 66410 of the Government Code), and any other division of land, including lot splits, except where the land division is brought about in connection with the purchase of such land by a public agency for public recreational use; change in the intensity of use of water, or of access thereto; construction, reconstruction, demolition, or alteration of the size of any structure, including any facility of any private, public, or municipal utility; and the removal or harvesting of major vegetation other than for agricultural purposes, kelp harvesting, and timber operations which are in accordance with a timber harvesting plan submitted pursuant to the provisions of the Z'berg-Nejedly Forest Practice Act of 1973 (commencing with Section 4511).”

Steps for Addressing Sea-Level Rise in Coastal Development Permits

The following steps provide general guidance for addressing sea-level rise in the project design and permitting process.

Step 1: Establish the projected sea-level rise range for the proposed project
Step 2: Determine how impacts from sea-level rise may constrain the project site
Step 3: Determine how the project may impact coastal resources, considering the influence of future sea-level rise upon the landscape
Step 4: Identify project design alternatives to both avoid impacts to coastal resources and minimize risks to the project
Step 5: Finalize project design and submit CDP application

The goal of these steps is to ensure careful attention to minimizing development risk and to avoid impacts to coastal resources in light of current conditions and the changes that may arise over the life of the project. Many project sites and proposed projects may raise issues not specifically contemplated by the following guidance steps or the permit filing checklist at the end of this section. Notwithstanding, it remains the responsibility of the project applicant to adequately address these situations so that consistency with the Coastal Act and/or LCP may be fully evaluated. Throughout the CDP analysis, applicants are advised to contact planning staff (either at the Commission or the local government, whichever is appropriate) to discuss the proposed project, project site, and possible resource or hazard concerns. The extent and frequency of staff coordination may vary with the scale of the proposed project and the constraints of the proposed project site. Larger projects and more constrained sites will likely necessitate greater coordination with local government and Commission staff.

Step 1 - Establish the projected sea-level rise range for the proposed project

A projected sea-level rise range should be obtained from the best available science. Those projections should be adjusted for local conditions and cover the expected design or economic life of the proposed project, as the ultimate objective will be to assure that the project is safe from coastal hazards, without the need for shoreline protection or other detrimental hazard mitigation measures, as long as it exists.

- **Define Expected Project Life or Design Life**: The expected or proposed project life will help determine the amount of sea-level rise to which the project site could be exposed while the development is in place. Some LCPs include a specified design life for new development. If no time frame is provided, a minimum of 75 to 100 years should be considered as the design life for primary residential or commercial structures. An indefinite time period might be appropriate for resource protection or enhancement projects such as a trail or coastal habitat conservation or restoration project. A long, but defined time period may be appropriate for critical infrastructure. A shorter time period might be appropriate for ancillary development, amenity structures, or moveable or expendable construction. The proposed project life may need be to be shortened if subsequent steps identify that the project site is constrained by hazards (such as flooding,

erosion or steep slopes) or contains coastal resources (such as wetlands, ESHA or cultural resources) such that development cannot be sited and designed to be safe for a 50- or 75-year proposed life, without reliance upon protection efforts or impacts to the coastal resources.

- **Determine Sea-Level Rise Range:** The project analysis should use a range of sea-level rise projections based on the best available science. At present, the 2012 NRC report is considered to be the best available science. Appendix B provides information on how to determine sea-level rise amounts for years that are not included in the NRC report and, if needed, how to modify the NRC sea-level rise projections to account for local vertical land motion. At a minimum, low and high sea-level rise projections for the proposed life of the project should be used for project analysis and evaluation.

  For project locations in the vicinity of Humboldt Bay and the Eel River estuary, the regional NRC sea-level rise projections will need to be modified to adjust for localized vertical land motion, and this is discussed further in Appendix B. Adjustments for vertical land motion are not recommended for other locations.[21] However, if sea-level rise projections are modified for areas other than the Humboldt Bay region, at least one scenario for the analysis of impacts should use the high value from the unmodified NRC projections.

Expected outcomes from step #1*: This step should provide a proposed or expected project life and corresponding range of sea-level projections that will be used in the following analytic steps. If subsequent steps establish that the proposed site is too constrained for the proposed development to remain safe for the full project life without reliance upon additional protection measures and resources impacts, the expected life of the development may need to be modified to allow a shorter period for use of the proposed site.*

CDP Application Information from Step #1: *This step should provide information on the proposed project life and the range of sea-level rise projections to be used in project analysis.*

Step 2 - Determine how impacts from sea-level rise may constrain the project site

The Coastal Act requires that development minimize risks from coastal hazards. Sea-level rise can both present new hazards and exacerbate hazards that are typically analyzed in CDP

[21] A three-member subcommittee of the OPC Science Advisory Team (OPC-SAT) advised using the NRC projections, without modification, for all California locations except between Humboldt Bay and Crescent City. The OPC-SAT subcommittee stated, "We do not believe that there is enough certainty in the sea-level rise projections nor is there a strong scientific rationale for specifying specific sea-level rise values at individual locations along California's coastline." (OPC, 2013, pg. 10)

applications. In this step, determine the extent of sea-level rise impacts now and into the future, and determine how to minimize those hazards when siting the project.

Impacts associated with sea-level rise generally include erosion, inundation, flooding, wave impacts, and saltwater intrusion. An assessment of these impacts often is required as part of a routine hazards assessment or the safety element of the LCP. Therefore, information in the local LCP can provide an initial determination of concern for the project in question, if available. However, proposed development will often need a second-level, site-specific analysis of hazards to augment the more general LCP information.

2.1 Analyze relevant sea-level rise impacts.

A CDP application for new development in a hazardous area should include reports analyzing of the anticipated impacts to a project site associated with rising sea level. Generally, the analyses pertinent to sea-level rise include geotechnical stability, erosion, and flooding/inundation, and these analyses are described in detail below. Depending on the site, however, different analyses may be required. Applicants should work with planning staff (Coastal Commission or local government staff) to perform a pre-application submittal consultation to determine what analyses are required for their particular project. After the submission of the CDP, any additional analyses that are required will be listed in an application filing status review letter.

The professionals who are responsible for these studies are familiar with the methodologies for examining their respective impacts. However, the methodologies sometimes do not always adequately examine potential impacts under rising sea level conditions, as established by best available science. Appendix B goes through the various steps for incorporating the best available science on sea-level rise into the more routine analyses, which are summarized below:

- **Geologic Stability:** The CDP should analyze site-specific stability and structural integrity without reliance upon existing or new protective devices (including cliff-retaining structures, seawalls, revetments, groins, buried retaining walls, and caisson foundations) that would substantially alter natural landforms along bluffs and cliffs. In most situations, this stability analysis will be combined with the erosion analysis (below) to fully establish the safe developable area.

- **Erosion:** The CDP application should include an erosion analysis and map illustrating the extent of erosion that potentially could occur from current processes, as well as future erosion hazards associated with low and high sea-level rise scenarios over the life of the project. If possible, these erosion conditions should be shown on a site map, and the erosion zone used to help establish locations on the parcel or parcels that can be developed without reliance upon existing or new protective devices (including cliff-retaining structures, seawalls, revetments, groins, buried retaining walls, and caissons) that would substantially alter natural landforms along bluffs and cliffs. In most situations, this erosion analysis will be combined with the geologic stability (above) to fully establish the safe developable area. And, if the analyses show that the proposed development cannot be safe over the proposed project life, without reliance upon protection or impacts to resources, the proposed project life may need to be shortened.

- **Flooding and Inundation:** The CDP application should include analysis of the extent of flooding or inundation that potentially could occur over the anticipated life of the project from a minimum of low and high sea-level rise scenarios, and under a range of conditions that could include high tide, storm surge, water elevation due to El Niños, Pacific Decadal Oscillations, a 100-year storm event, and the combination of long-term erosion and seasonal beach erosion. If possible, this information and resulting flood zones should be shown on a site map.

    - **Flood Elevation Certificate**: If a site is within a FEMA-mapped 100-year flood zone, building regulations, in implementing the federal flood protection program, require new residences to have a finished floor elevation above Base Flood Elevation (BFE) (generally one foot). The CDP application should include a flood elevation certificate prepared by a registered land surveyor, engineer, or architect, demonstrating that the finished floor foundation of the new structure will comply with the minimum FEMA guidelines and building standards. At this time, the Flood Certificate does not address sea-level rise related flooding. Thus, in general, a certificate is not adequate to address Coastal Act and LCP standards for demonstrating that future flood risk has been minimized. In addition, designing to meet FEMA requirements may be in conflict other resource constraints, such as protection of visual resources, community character, and public access and recreation.

- **Other Impacts**: Any additional sea-level rise related impacts that could be expected to occur over the life of the project, such as saltwater intrusion should be evaluated. This may be especially significant for areas with a high groundwater table such as wetlands or coastal resources that might rely upon groundwater, such as agricultural uses.

2.2 Evaluate the sea-level rise impacts resulting from multiple sea-level rise scenarios.

Because there is scientific uncertainty associated with sea-level rise projections, sea level projections for a certain time period are usually given as a range. (For example, the NRC predicts 10 – 143 centimeters of sea-level rise by 2100 for land north of Cape Mendocino.) Therefore, applications should analyze the hazards that may result from both the low and high bounds of these ranges, along with medium values if necessary. This technique is called scenario-based analysis: it examines hazards such as inundation, flooding, wave impacts and erosion for various levels of sea level that can be expected to occur over the life of the development. The analysis of various sea-level rise scenarios will allow the project planners to understand project vulnerabilities, including tipping points where the response of the project to sea-level rise will change significantly (for example, transitioning from periodic flooding to inundation, or rapid acceleration of erosion).

This guidance recommends that at least two sea-level rise scenarios be analyzed – a low and high amount of sea-level rise. For example, for a proposed development location that might only be at risk from flooding at the end of its expected economic life and with a high projection of sea-level rise it might be appropriate to address this future flood risk through future adaptation whereas

flood risks for a site that will be at risk from flooding with a very small projection of sea-level rise might need to address these future risks through more immediate steps. Therefore, it is important that the analyses for a proposed project examine the consequences associated with a range of sea-level rise projections appropriate to the project's expected life.

If there are large changes in the hazard zones between these two sea-level rise amounts, additional analyses may help determine the tipping points. Such tipping points might be indications of constraints to the site, such that its use as a development site may be severely constrained sometime in the future.

Finally, scenario-based analyses can help determine the long-term compatibility of the proposed site and the proposed development. The impacts analyses may identify that the proposed site cannot safely be used for the proposed project life. If this is the case, additional analyses for a shorter proposed project life may be appropriate.

Expected outcomes from step #2*: This step should provide detailed information about the sea-level rise related impacts that can occur on the site and changes that will occur over time. High risk and low risk areas of the site should be identified. The scenario-based analyses should also provide information on the amount of sea-level rise that could occur over the proposed development life, without relying upon existing or new protective devices. This step should also determine whether the project site will be constrained by hazards such that the proposed project life should be modified.*

CDP Application Information from Step #2: *This step should provide information and maps of the site-specific hazards and areas that can safely support development. Site-specific hazards include areas of geologic instability, erosion, flooding, inundation, and potentially saltwater intrusion or groundwater elevation.*

Step 3 - Determine how the project may impact coastal resources, considering the influence of sea-level rise upon the landscape over time

The Coastal Act requires that development avoid impacts to coastal resources. Sea-level rise will cause likely coastal resources to change over time. Therefore, in this step, analyze how sea-level rise will affect coastal resources now and in the future so that alternatives can be developed in Step 4 to minimize the project's impacts to coastal resources throughout its lifetime.

All coastal resources – public access and recreation, water quality, natural resources (such as ESHA and wetlands, etc.), agricultural resources, natural landforms, scenic resources, and archeological and paleontological resources – will need to be considered in this step. As in Step 3, this analysis should be repeated using both the low and high bounds of the range of sea-level rise projections that are appropriate for the expected life of the project should be used in the analysis. Also, if the proposed project may be changed or modified during the initial project design stage, or due to future adaptation, the resource impacts of these changes must also be analyzed.

3.1 Analyze coastal resource impacts and hazard risks

Analysis of resource impacts will require information about the type and location of the resources on or in proximity to the proposed project site. The following discussion of each resource will help identify the key impacts to each that might result from either sea-level rise or the proposed development. If coastal resources will be affected by sea-level rise, such as changes to the area and extent of a wetland or riparian buffer, these changes must be considered in the analysis. Much of the following discussion recommends analysis of impacts from current and future inundation, flooding, and erosion. Appendix B provides guidance on how to undertake this analysis and includes lists of suggested resources that can provide data, tools, or other resources to help with these analyses.

Information on the following resources is included. To skip to a section, click on the links below:

New Development

New development must be sited and designed to minimize risks from hazards. Consider the following steps to identify potential risks from hazards:

- ✓ Identify all hazards that may impact the proposed project site or proposed development. Such hazards can include shoreline erosion, bluff erosion, flooding, inundation, elevated ground water, and saltwater intrusion. Once hazards are identified, if possible map these hazards in relation to the location of the proposed project.

- ✓ Determine whether any hazard zones will be altered or affected by sea-level rise over the proposed life of the project. Sea-level rise will alter the extent of flooding, inundation as well as the rates of shoreline and bluff erosion. At a minimum, use a low and high projection of sea-level rise appropriate for the location and the proposed life of the project to establish the zone of likely changes to hazard zones.

- ✓ If any natural landforms will be altered by sea-level rise, map or otherwise identify the likely changes to location of these coastal resources over the life of the proposed project.

- ✓ Identify locations of the proposed project site that can support development without being located within a hazard zone. Overlay with development constraints (fault zones, landslides, steep slopes, property line setbacks, etc.) and with other coastal resource constraints.

Public Access and Recreation
Public access and recreation resources include lateral and vertical public accessways, public access easements, beaches, recreation areas, public trust lands,[22] and trails, including the California Coastal Trail. These areas may become hazardous or unusable during the project life due to sea-level rise. Steps to identify potential risks to public access and recreation include:

- ✓ Identify all public access locations on or near the proposed project site and, if possible, map these resources in relation to the location of the proposed project.

- ✓ Determine whether any access locations will be altered or impacted by sea-level rise over the proposed life of the project. Such impacts could result from flooding, inundation, or shoreline erosion. At a minimum, use a low and high projection of sea-level rise appropriate for the location and the proposed life of the project to establish the zone of likely changes to public access and recreation.

- ✓ If any access locations will be altered by sea-level rise, map or otherwise identify the likely changes to location of these access resources over the life of the proposed project.

- ✓ Identify locations of the proposed project site that can support development without encroachment onto the existing or future locations of these access locations. Overlay with development constraints (fault zones, landslides, steep slopes, property line setbacks, etc.) and with other coastal resource constraints.

Coastal Habitats (ESHA, wetlands, etc.)
Coastal habitats, especially those that have a connection to water, such as beaches, intertidal areas, and wetlands, can be highly sensitive to changes in sea level. Steps to identify potential resource impacts associated with the project include:

- ✓ Identify all coastal habitats on or near the proposed project site and, if possible map these resources in relation to the location of the proposed project.

- ✓ Determine whether any coastal habitats will be altered or affected by sea-level rise over the proposed life of the project. Such impacts could result from flooding, inundation, shoreline erosion, or changes to surface or groundwater conditions (see discussion below on water quality). At a minimum, use a low and high projection of sea-level rise appropriate for the location and the proposed life of the project to establish the zone of likely changes to coastal habitats.

[22] The State Lands Commission has oversight of all public trust lands and they should be contacted if there is any possibility that a public trust lands might be involved in the proposed project. As a general guide, public trust lands can include, but not be limited to tide and submerged lands.

- ✓ If any coastal habitats will be altered by sea-level rise, map or otherwise identify the likely changes to location of these coastal resources over the life of the proposed project.

- ✓ Identify locations of the proposed project site that can support development without encroachment onto the existing or future locations of these coastal habitats. Overlay with development constraints (fault zones, landslides, steep slopes, property line setbacks, etc.) and with other coastal resource constraints.

Natural Landforms
Natural landforms can include coastal caves, rock formations, bluffs and cliffs. Steps to identify natural landforms at risk include:

- ✓ Identify all natural landforms on or near the proposed project site and, if possible map these resources in relation to the location of the proposed project.

- ✓ Determine whether any natural landforms will be altered or impacted by sea-level rise over the proposed life of the project. Such impacts could result from flooding, inundation or shoreline erosion. At a minimum, use a low and high projection of sea-level rise appropriate for the location and the proposed life of the project to establish the zone of likely changes to natural landforms.

- ✓ If any natural landforms will be altered by sea-level rise, map or otherwise identify the likely changes to location of these coastal resources over the life of the proposed project.

- ✓ Identify locations of the proposed project site that can support development without encroachment onto the existing or future locations of these natural landforms. Bluffs and cliffs can often require additional analysis for slope stability to determine the setback from the eroded bluff face that can safely support development. Overlay with development constraints (fault zones, landslides, steep slopes, property line setbacks, etc.) and with other coastal resource constraints.

Agricultural Resources
Agricultural resources may be affected by sea-level rise through changes to surface drainage and the groundwater table. Other changes can result from flooding, inundation or saltwater intrusion. If agricultural lands are protected by levees or dikes, agricultural lands can be affected by changes to the stability or effectiveness of these structures. Steps to identify risks to agricultural resources include:

- ✓ Identify whether the proposed project site is used for or zoned for agricultural uses or is in the vicinity of or upstream of lands in agricultural use.

- ✓ Identify surface water drainage patterns across the site or from the site to the agricultural use site.

- ✓ If any drainage patterns are closely linked to and likely influenced by the elevation of sea level, examine changes in drainage patterns with rising sea level, both on the proposed site or the agricultural use site.

- ✓ Identify the elevation of the groundwater table. Since groundwater can fluctuate during periods of rain and drought, attempt to identify the groundwater zone.

- ✓ Estimate the likely future elevation of the groundwater zone, due to sea-level rise. At a minimum, use a low and high projection of sea-level rise appropriate for the location and the proposed life of the project to establish the zone of likely changes to groundwater.

- ✓ Evaluate whether changes in groundwater will alter the proposed site conditions.

Water Quality

Sea-level rise may cause drainages with a low elevation discharge to have water back-ups. It may also cause a rise in the groundwater table. Both these changes could alter on-site drainage and limit future drainage options. If the proposed site must support an on-site wastewater treatment system, or if drainage and on-site water retention will be a concern, consider the following, as appropriate:

- ✓ Identify surface water drainage patterns across the site.

- ✓ Examine changes in drainage patterns with rising sea level of any drainage patterns that are closely linked to and likely influenced by the elevation of sea level. At a minimum, use a low and high projection of sea-level rise appropriate for the location and the proposed life of the project to establish the zone of likely changes to drainage patterns.

- ✓ Identify the elevation of the groundwater table. Since groundwater can fluctuate during periods of rain and drought, attempt to identify the groundwater zone.

- ✓ Estimate the likely future elevation of the groundwater zone, due to sea-level rise. At a minimum, use a low and high projection of sea-level rise appropriate for the location and the proposed lift of the project to establish the zone of likely changes to groundwater.

- ✓ Evaluate whether changes in groundwater will alter the proposed site conditions.

Archeological and Paleontological Resources

The Coastal Act protects archeological and paleontological resources. However, there are other state and federal laws that govern the protection or disturbance of these sites and of the public disclosure of their locations. The appropriate state and federal agencies and tribal authorities should be involved with land use decisions involving archeological and paleontological resources. Steps to identify archeological and paleontological resources at risk include:

- ✓ Identify all archeological and paleontological resources on the proposed project site.

- ✓ Determine whether any archeological and paleontological resources will be impacted by sea-level rise, including impacts from flooding, inundation or shoreline erosion. At a minimum, use a low and high projection of sea-level rise appropriate for the location and the proposed life of the project to establish the zone of likely changes to archeological and paleontological resources.

- ✓ If any archeological and paleontological resources will be altered by sea-level rise, identify the likely changes to location of these coastal resources over the life of the proposed project.

- ✓ Identify locations of the proposed project site that can support development and avoid or minimize impacts to archeological and paleontological resources. Overlay with development constraints (fault zones, landslides, steep slopes, property line setbacks, etc.) and with other coastal resource constraints.

Scenic Resources

Visual and scenic resources include views to and along the ocean and scenic coastal areas. Development modifications to minimize risks to sea-level rise could have unintended negative consequences for scenic resources, including creating a structure that is out of character with the surrounding area and altering natural landforms. Steps to identify impacts to scenic resources include:

- ✓ Identify all scenic views to and through the proposed project site from public vantage points such as overlooks, access locations, beaches, trails, the Coastal Trail, public roads, parks, etc. and, if possible map these views and view lines in relation to the location of the proposed project.

- ✓ Determine whether any public vantage points will be impacted by sea-level rise, especially beaches, trails and the Coastal Trail. Such impacts could result from flooding, inundation or shoreline erosion. At a minimum, use a low and high projection of sea-level rise appropriate for the location and the proposed life of the project to establish the zone of likely changes to scenic resources.

- ✓ If any access locations, beaches, trails, the Coastal Trail or public trust lands will be altered by sea-level rise, map or otherwise identify the likely changes to location of these coastal resources over the life of the proposed project.

- ✓ Identify locations of the proposed project site that can support development and avoid or minimize impacts to scenic views from current and future vantage points. Overlay with development constraints (fault zones, landslides, steep slopes, property line setbacks, etc.) and with other coastal resource constraints.

3.2 Synthesize and assess development and resource constraints

After completing the detailed analysis of each coastal resource, the applicant should summarize the potential resource impacts. If feasible, applicants should produce a constraints map illustrating the location and the extent of resource impacts that could occur over the life of the development. Based on the analysis of resource impacts and potential hazard risks over the life of the development, the applicant should develop an overlay identifying the development and resource constraints.

3.3 Identify areas suitable for development

The final part of this step is to identify the locations of the project site that could support some level of development without impacts to coastal resources and without putting the development at risk.

Expected outcomes from step #3*: Upon completing this step, the applicant should have detailed information about the types of coastal resources on the project site and the level of risk that sea-level rise poses to each resource, including resource locations and the extent of resource impacts that could occur over the life of the proposed project. This step should also provide an overlay of all development and resource constraints, and clearly identify the locations on the proposed project site that could support some level of development without impacts to coastal resources and without putting the development at risk.*

Step 4 - Identify project design alternatives that avoid resource impacts and minimize risks to the project.

In this step, identify project alternatives and analyze their associated resource impacts and sea-level-related risks. Projects must be sited and designed to address all applicable Coastal Act and LCP requirements. This requires both that the proposed development minimize risks from coastal hazards and that the proposed development avoid impacts to coastal resources. The analysis of resource impacts and development risks (Step 3) will provide a good understanding of these two concerns – both the risks to the development and the extent and type of resource constraints that exist on the proposed project site.

Employ Hazard Avoidance whenever possible: The best way to minimize risks to life and property from sea-level rise related hazards is to avoid hazardous locations and to keep development out of harm's way. If feasible, development should not be proposed in locations subject to current or future risks from inundation, flooding or erosion. Depending upon the proposed development and proposed development site, it may be possible to site the entire proposed development in a low or non-hazardous location. The analysis of development risks and coastal resources (Step 3) will identify if there are locations on the proposed project site that can support development without need for future shoreline protection, bluff retention or impacts to coastal resources. If such locations are available, a development footprint can be established that avoids all hazard areas, without impacts to coastal resources.

In other situations, the proposed development may have to be modified or resized to fit within the low hazard portion of the site. In addition, land divisions, including lot line adjustments, in high hazard areas can change hazard exposure and should be undertaken only when they can be shown to not worsen or create new vulnerability. In particular, no new lots or reconfigured lots with new development potential should be created if they cannot be developed without additional shoreline hazard risks.

Employ Hazard Minimization when Avoidance is infeasible: If hazard avoidance is not possible, a second approach to minimize risks from natural hazards is to limit exposure to hazards, or the likelihood that a project could come into contact with the hazards. When hazard avoidance is infeasible, there are, in general, two basic approaches for minimizing sea-level rise related hazards while protecting coastal resources. These approaches depend upon whether or not the proposed project will likely need to stay in a fixed location or whether it can be easily relocated. If the project will be at a fixed location, the greatest opportunity for minimizing risks may come through siting and design for future sea level conditions, with adaptation options incorporated into the design in the event that sea level rises more than anticipated in the design. If the project itself can relocate and adapt to rising water levels, then the greatest opportunity for minimizing risks may come through future modifications to the structure or relocation, with this adaptive flexibility included in the initial siting and design. A wastewater treatment plant might be an example of the former and wetland restoration or a coastal trail might be an example of the latter. Of course, many projects might take a hybrid approach, assuming a fixed location, but incorporating incremental relocation, such as modular structures that are designed for some anticipated amount of sea-level rise, with options for removal as portions of the structure become threatened. Opportunities to ensure minimization of risks will be different for a very fixed type of development and one that can change or relocate. However, the key goal of either approach will be to site, design, modify or adapt proposed projects such that they remain safe from current and future sea-level rise associated hazards, and cause no current or future resource impacts.

Design Adaptation Strategies to minimize risks and avoid resource impacts. If it is not feasible to site or design a structure to completely avoid sea-level rise impacts over the anticipated life of the structure, the applicant should instead minimize impacts and develop a sea-level rise adaptation strategy, including steps to relocate or modify the development as needed to prevent risks to the development or to coastal resources. This process should be conducted as part of the alternatives analysis. See Appendix C for more information on adaptation measures. For a list of guidebooks, online clearinghouses, and other sea-level rise adaptation resources, see Appendix D.

Steps involved in designing an appropriate adaptation strategy may include:

- **Sea-Level Rise Design Amount:** If the likelihood of impacts is expected to increase with rising sea level, it may be necessary to design for some amount of sea-level rise and include design flexibility that will allow future project changes or modifications to prevent impacts if the amount of sea-level rise used in the design is not sufficient. The amount of sea-level rise used in this process may vary on a case-by-case basis.

- **Adaptation Options:** Evaluate each adaptation option for efficacy in protecting the development. Also, evaluate the consequences from each proposed adaptation measure

to ensure it will not have adverse impacts on coastal and sensitive environmental resources, including visual impacts and public access.

For example, an option that is often considered for sea-level rise is to elevate the development or the structures that are providing flood protection. However, elevated structures will change the scenic quality and visual character of the area. Also, elevation of the main development may be of little long-term utility to the property owner if the supporting infrastructure, such as the driveways, roads, utilities or septic systems are not also elevated or otherwise protected. Elevation of existing levees or dikes can provide flood protection for an area of land and all the development therein. However, the foundation of the levee or dike must be augmented to raise the height of most levees, and the increased footprint of the foundation could have impacts on intertidal area, wetlands, or other natural resources. Thus, the long-term options for adaptation should be considered as part of any permit action, to ensure that current development decisions are not predetermining resource impacts in the future.

- **Design Constraints:** Determine whether there are any significant site or design constraints that might prevent future implementation of possible sea-level rise adaptation measures. Some project locations may be constrained due to lot size, sea level related hazards, steep slopes, fault lines, the presence of wetlands or other ESHA, or other constraints such that no safe development area exists on the parcel. Ideally, such parcels would be identified during the LCP vulnerability analysis, and the land use and zoning designations would appropriately reflect the constraints of the site. There may be few options for minimizing risks. Nevertheless, care should be taken to avoid, or minimize as appropriate, resource damages from current or future sea-level rise related hazard areas.

- **Monitoring:** Develop a monitoring program or links to other monitoring efforts to ensure that the proposed adaptation measures will be implemented in a timely manner. Carefully identify the triggers that would lead to project modifications or adaptation efforts. The expected project life may be a project element that could be modified to allow some development to occur now, but to allow for removal of the development as it becomes threatened by erosion or flooding, or as it causes impacts to coastal resources. This would be especially appropriate for project sites where the development might be safe for the low range of sea-level rise but not for the higher range of sea-level rise. A flexible project life could include various triggers or change points that would cause the project to be modified or removed before the end of the expected life of the development. This could allow some safe use of an otherwise constrained site and ensure long-term resource protection.

Expected outcomes from step #4*: This step may involve an iterative process of project modifications and reexamination of impacts, leading to one or more alternatives for the project site. The alternative that will minimize risks from coastal hazards and avoid or minimize impacts to coastal resources should be identified. Possible adaptation options could be identified and analyzed, if appropriate. If the site is very constrained, modifications to the expected project life might be suggested.*

Step 5 – Finalize project design and submit CDP application

After Step 4, the applicant should have developed one or more project alternatives. The alternatives should include adaptation strategies if hazards cannot be avoided entirely and are instead minimized. The next step involves the following:

1. **Work with the planning staff to complete the CDP application**. This step might involve an iterative process, wherein planning staff requests more information about the proposed project or project alternatives to help in review for compliance with the Coastal Act. This process may be repeated until the application provides the studies, analysis and project review necessary for planning review. The CDP application covers the general information needed for a complete CDP application. This guidance and the provided Filing Checklist for CDP Applications provides more specific guidance on information that will be needed for project sites that are likely to be subject to sea-level rise impacts over the life of the proposed development.

2. **Submit a complete CDP application.** Once a complete application is submitted, the planning staff will then review the permit, and if necessary request additional information or modifications to the project. Please consult the Coastal Commission website or contact your district office for instructions on how to complete a CDP application.

3. **Permit action.** The outcome of a permit submittal will be project approval, approval with conditions, or denial. Based on the regulatory decision, the project may be constructed, or additional modifications and condition requirements may have to be met.

4. **Monitor and revise.** CDP approvals will often include conditions that require monitoring. Applicants should monitor the physical impacts of sea-level rise on the project site and respond as necessary. Applicants may also monitor changes in sea-level rise science.

Expected outcomes from step #5*: This step, combined with supporting documentation from the previous steps, should provide a basis for evaluating the proposed project's hazard risks and impacts that can result from sea-level rise. Such an analysis will provide one of the bases for project evaluation and complements the other resource evaluations and analyses that are part of a complete CDP application.*

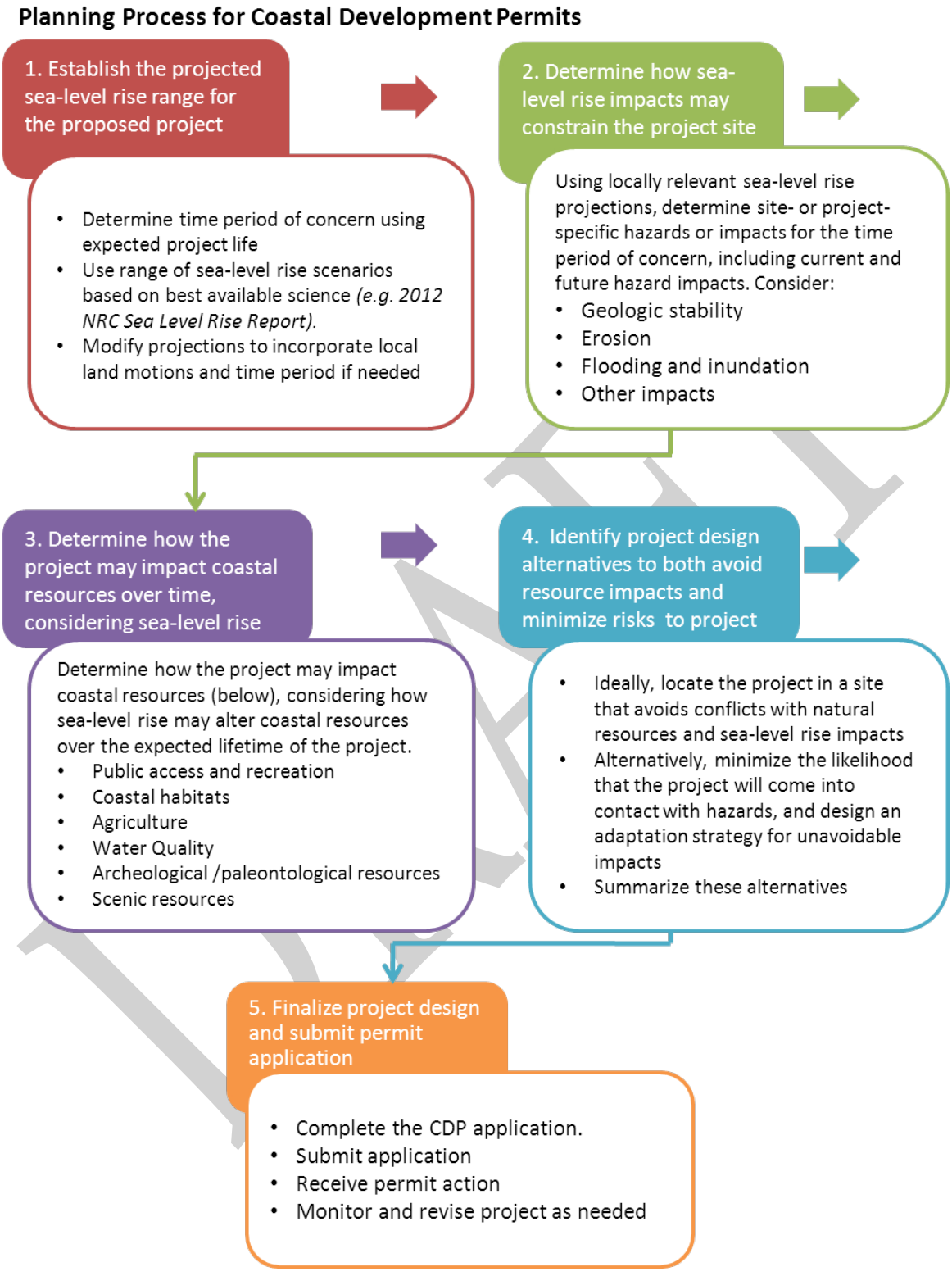

Figure 6. Flowchart for addressing sea-level rise in Coastal Development Permits

Filing Checklist for Sea-Level Rise Analysis

- Proposed/Expected Project Life, if appropriate.
- Sea-Level Rise Projections Used in Impacts Analyses
- Impacts Analyses (possibly from Vulnerability Assessment)
  - Structural and Geologic Stability
    - Perform Geotechnical Report and Erosion Analysis
    - Identify blufftop setback and safe building area
    - Show setback, safe building area and proposed project footprint (site maps)
  - Erosion Amount over Expected Project Life
    - Perform Coastal Processes Study and Erosion Analysis
    - Quantify total erosion amount for proposed project site
    - Show retreat along with proposed project footprint (site maps)
  - Flooding and Inundation Risks
    - Perform Coastal Processes Study and Wave run-up analysis
    - Quantify flood elevation and flooding extent
    - Show flood extent with proposed project footprint (site map)
    - Show flood elevation on site profile, with proposed project elevation
    - Provide Flood Certificate if in FEMA designated 100-year Flood Zone
  - Tipping points for Sea-Level Rise Impacts, specific to proposed project site
- Impacts to Coastal Resources (possibly from Environmental Assessment) for current conditions and changes due to sea-level rise and related impacts
  - Public Access and Recreation
    - Show access resources and future changes (site maps)
  - Water Quality, surface and groundwater
    - Provide surface drainage patterns and runoff and future changes (site maps)
    - Provide zone of groundwater elevation
  - Coastal Habitats
    - Provide wetland Delineation, ESHA determination, if appropriate
    - Provide boundary determinations or State Lands review, if appropriate
    - Show all coastal habitats and future changes (site maps)
  - Agricultural Resources
    - Show agricultural resources and future changes (site maps)
  - Natural Landforms
    - Show all natural landforms and future changes (site maps)
  - Scenic Resources
    - Show views from public access and future changes due to access changes
  - Archeological and Paleontological Resources
    - Show archeological/paleontological resources and future changes (site maps)
  - Overlay all Coastal Resources to Establish Areas Suitable for Development (site maps)
- Analysis of Proposed Project and Alternatives
  - Provide Design Amount of Sea Level
  - Provide analysis of the proposed project and alternatives
  - Identify proposed current and future adaptation strategies
  - Show avoidance efforts (site map)
  - Identify hazard minimization efforts that avoid resource impacts (site maps)

Example for Addressing Sea-Level Rise in Coastal Development Permits

Three case studies have been developed as examples of how to include sea-level rise considerations into the CDP process. The three sample projects are a wetland restoration project, a new bluff-top residential development, and a new wastewater treatment facility. These three examples will follow each of the recommended CDP steps, showing how the guidance could be applied in specific situations.

Step 1: Establish the projected sea-level rise range for the proposed project

- *Wetland Restoration Project:* If wetland restoration efforts are intended as mitigation for a development project, the lifetime for the wetland restoration should be at a minimum, the same as the lifetime of the development project, and sea-level rise ranges should be projected for the time period. For wetland restoration projects in which the desired outcome is the protection of the wetland in perpetuity, sea-level rise ranges should be projected over a minimum of 100 years, with consideration for ongoing adaptive management.
- *Bluff-top Residential Development:* The lifetime of the project is assumed to be at least 75 years. High and low sea-level rise projection ranges are established, appropriate for the proposed area over the assumed 75-year project life.
- *Wastewater Treatment Facility:* Wastewater treatment facilities are normally critical infrastructure. For this example a minimum life of 100 years is assumed. High and low sea-level rise projections ranges are established, appropriate for the proposed area over the assumed 100-year project life.

Step 2: Determine how impacts from sea-level rise may constrain the project site

- *Wetland Restoration Project:* Current topography of the wetland area is mapped, current barriers to inland migration are identified, and an analysis of erosion and flooding potential (and subsequent effects to wetland extent) is performed for various sea-level rise scenarios. Potential changes to groundwater are evaluated. Potential changes in sediment flows or other physical properties as a result of changing conditions are examined. It is determined that open space exists behind the wetland to allow for inland migration over time.
- *Bluff-top Residential Development:* The average long-term bluff retreat rate, erosion rate due to various sea-level rise scenarios, and erosion potential from 100-year storms and other extreme events are determined. The geologic stability of the bluff over the life of the development is analyzed assuming that no protective structure (such as a seawall) will be built.
- *Wastewater Treatment Facility:* Erosion and flooding potential over the lifetime of the facility under both a low and a worst-case scenario sea-level rise projection are analyzed, as are current and future wave run-up and storm impacts for 100-year storms. The geologic stability of the site over the life of the facility is analyzed assuming that no protective structure will be built. Potential damage to infrastructure (for example corrosion due to salt water intrusion) is examined.

Step 3: Determine how the project may impact coastal resources, considering the influence of sea-level rise upon the landscape over time

- *Wetland Restoration Project:* Coastal resources present in the proposed project site are mapped and sea-level rise impacts to these resources are analyzed over the lifetime of the project. It is unlikely that the project will have any adverse impact on coastal resources. Barriers to wetland migration are examined and, it is determined that enough open space currently exists to allow for the wetland to migrate inland over time. The few barriers that exist can be modified in the future, if necessary. This will allow for the continued maintenance of habitat area and other ecosystem services.
- *Bluff-top Residential Development:* Maps that identify scenic overlooks, the bluff extent, and adjacent coastal habitats including the fronting beach are developed, and descriptions of each are provided. Opportunities for public access are identified. Impacts to each of these resources as a result of sea-level rise are analyzed, as are impacts that would result from the development project. It is determined that the development has the potential to disturb natural migration of a fronting beach if a protective structure is needed. However, no such structure is planned over the lifetime of the development under any sea-level rise scenario.
- *Wastewater Treatment Facility:* Maps are developed that identify coastal resources in the area and impacts to these resources resulting from sea-level rise are analyzed. As with the bluff-top development, any protective structure would have detrimental effects to the fronting beach, but no such structure is determined to be necessary. Any potential impacts to adjacent habitat areas or to water quality as a result of damage to infrastructure (for example sewage outflow or backup of seawater into the system) are examined under the range of sea-level rise projections for the life of the facility.

Step 4: Identify project design alternatives that avoid resource impacts and minimize risks to the project

- *Wetland Restoration Project:* There are no concerns related to detrimental impacts to coastal resources as a result of this project. Natural barriers will be removed through grading and contouring of the land to ensure that the wetland has the ability to migrate inland with sea-level rise and that hydrologic function will be maintained. Inland areas are protected into the future to ensure the space will be open for migration. Additionally, a plan is included to monitor changes in sea-level, sediment dynamics, and overall health of the wetland so that changes can be made as needed.
- *Bluff-top Residential Development:* The optimal site for a bluff-top residential development is one that avoids the hazards identified in Step 2 and impacts to coastal resources identified in Step 3 over the life-time of the project. If the proposed site does not avoid risks, alternative sites should be identified and examined. If no such site exists, efforts should be made to minimize hazards and impacts to resources. Minimization efforts may include: building with an extra setback from the bluff-face, developing a managed retreat plan, and designing buildings to be easily relocated. A plan to monitor rates of erosion at various places along the bluff as well as any

impacts to adjacent resources is developed, and erosion rates/scenarios that would trigger the need for retreat are identified.

- *Wastewater Treatment Facility:* The optimal site for a wastewater treatment facility is one that avoids the hazards identified in Step 2 and impacts to coastal resources identified in Step 3 over the life-time of the project. If the proposed site does not avoid risks, alternative sites should be identified and examined. If no such site exists, efforts should be made to minimize hazards and impacts to resources. Minimization efforts may include: building the facility further back from the beach, elevating outflow pipes, and adding one-way valves to prevent backflow of sea-water into the system. A plan to monitor erosion rates along the beach as well as wave and storm impacts and any impacts to coastal resources caused by the facility is developed.

Step 5: Finalize project design and submit CDP application

- *Wetland Restoration Project:* The best site and design option is chosen and presented to the Commission or local government for the permit process.
- *Bluff-top Residential Development:* The best site and design option is chosen and presented to the Commission or local government for the permit process.
- *Wastewater Treatment Facility:* The best site and design option is chosen and presented to the Commission or local government for the permit process.